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Science

Airborne fine particles ($PM_{2.5}$) have been linked to adverse health effects and regional haze. $PM_{2.5}$ measurements indicate that the Tennessee Valley will have difficulty meeting the recently revised, stringent National Ambient Air Quality Standard for Particulate Matter. To better understand the sources and fate of $PM_{2.5}$ in the Tennessee Valley, TVA recently began operation of an enhanced monitoring station ("Supersite") on the western border of the Great Smoky Mountains National Park. Cooperating with TVA in this effort are the National Park Service, EPRI, the Department of Energy, and the Tennessee Department of Environment and Conservation.

Policy

Controlling fine particles will be a costly and difficult task. Developing cost-effective, efficient control strategies will require a greatly improved understanding of sources of particles and the processes that produce and transport them.

Development of an Enhanced Air Quality Monitoring Station ("Supersite") in the Great Smoky Mountains National Park

Background

Elevated levels of fine particles ($PM_{2.5}$) can be harmful to human health and also can contribute to regional haze. However, the sources of these particles and the processes by which they are formed remain poorly understood.

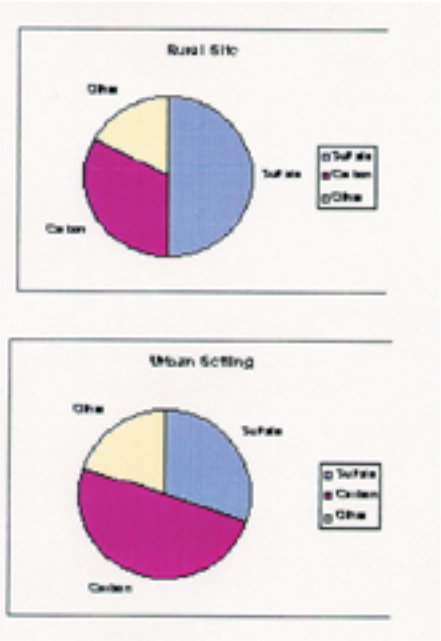
In September 1997, the U.S. Environmental Protection Agency (EPA) revised the National Ambient Air Quality Standards for Particulate Matter. The former "inhalable" particulate standards--those particles less than 10 micrometers in diameter, i.e., PM_{10}--were retained, and two new metrics for fine particles--those less than 2.5 micrometers in diameter, i.e., $PM_{2.5}$--were added. The new $PM_{2.5}$ annual standard was set at 15 micrograms per cubic meter ($\mu g/m^3$), and the new 24-hour $PM_{2.5}$ standard was set at 65 $\mu g/m^3$.

TVA and the Tennessee Valley air regulatory community have been proactive in developing and operating a network of prototype $PM_{2.5}$ monitoring stations. Beginning operation on Earth Day 1997, this sampling network has provided data for a preliminary assessment of $PM_{2.5}$ mass concentration levels. The network also has provided important information on the composition of $PM_{2.5}$ in the Tennessee Valley.

Results from the Tennessee Valley $PM_{2.5}$ Network indicate that annual average $PM_{2.5}$ concentrations in the Valley range from about 14 to 21 $\mu g/m^3$, with 14 representing the rural background and 21 representing the highest urban concentrations. Seven of the eight monitoring stations exceeded the level of the new $PM_{2.5}$

annual standard, but, with more than 1,000 samples collected to date, the network has yet to exceed the level of the new 24-hour standard.

Composition data suggest that, overall, Valley $PM_{2.5}$ is made up of about one-third sulfate, one-third organic and elemental carbon, and one-third "everything else." The proportional contribution of sulfate is greatest at the rural background station, while the urban samples show proportionally greater carbon contributions (see below).



What Is a "Supersite"?

A "Supersite" is an enhanced $PM_{2.5}$ monitoring site that exhibits three defining characteristics:

First, the Supersite is used to develop and test research instruments that improve the ability of scientists to quantify fine mass components that are not being accurately sampled by standard Federal Reference Method (FRM) samplers. Second, it is a location where tracer compounds, emitted from specific sources of fine particles or their gaseous precursors, are measured. Third, measurements are made with shorter time resolution than conventional FRM samplers. A time history of the levels of fine particle constituents is being developed from these data and will help determine daily human exposure to particles. It also will help scientists to understand the processes by which particles form and accumulate.

What Can the Supersite Tell Us?

First of all, the Supersite is critical to developing instrumentation that can more accurately quantify what is present in fine mass than can current FRM samplers. The FRM for fine mass significantly underestimates the contribution of organic carbon species. Interestingly, it is this underestimated organic fraction of fine particle mass that appears to evoke the greatest health concerns from toxicologists. The predominant sources of fine particulate carbon are incomplete combustion from vehicles, fuel storage and transport, industrial solvents, open burning, and biomass emissions.

Secondly, the use of tracer compounds will provide more accurate data concerning where fine particles and their precursors originate. They will help answer questions such as:

What fraction of the fine particulate mix originates from sulfur and nitrogen emissions from power plants?
What fraction from vehicle emissions?
•What fraction from other industrial sources?
What fraction from natural sources?

Such improved understanding will help regulators focus on the appropriate "culprit sources." Also, these data will allow the development of better control strategies for particulate matter.

Finally, examining the time history of the levels of various fine particle constituents will not only improve measurements of daily human exposure but also will help in developing models capable of making predictions of the timing and location of exceedances of EPA regulatory standards.

TVA's Triad Concept

TVA's approach is to develop a Supersite at Look Rock, a background location on the western edge of the Great Smoky Mountains National Park (GSMNP). This central monitoring station will be supported by two satellite monitoring stations about 25 km east (Cove Mountain) and 25 km north (Knoxville) of Look Rock (see map on back page).

$PM_{2.5}$ mass and composition measurements have been made at a core site near Knoxville as a part of the Tennessee Valley $PM_{2.5}$ Monitoring Network. TVA also has collaborated with the National Park Service (NPS) in making trace gas measurements at a mountaintop site (Cove Mountain) during the "ozone season." Previous measurements of mass and chemical composition of aerosols have been made at the Look Rock site by TVA and the NPS during intensive sampling exercises.

The TVA Supersite will operate principally at Look Rock, where continuous, year-round sampling of some parameters will be supplemented by focused campaign measurements in selected seasons. In addition to the Look Rock sampling, selected measurements of mass, light scattering and chemical composition will be made at Cove Mountain, and some enhanced monitoring will take place at the Ft. Loudoun Lake network site near Knoxville.

Future Plans

The continuous sampling of gas-phase species, the operation of the NPS instrumentation, and the every-third-day sampling of fine mass using the FRM sequential unit will continue during calendar year 1999. Duplicate FRMs will be operated on an accelerated schedule to obtain daily measures of chemical composition, including organic and elemental carbon.

The first intensive sampling period at the Look Rock site was in October 1999. Field testing was conducted for TVA's modified Particle Concentrated-Brigham Young Organic Sampling System sampler for semi-volatile constituents of fine mass and for a Tapered Element Oscillating Microbalance continuous fine mass sampler modified to collect aerosols at constant humidity.

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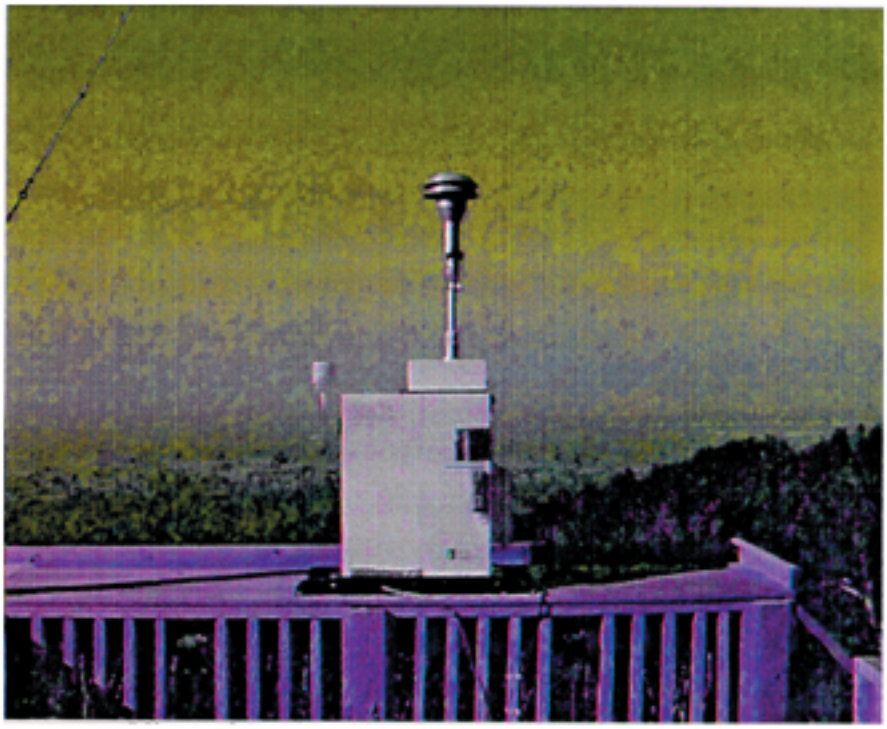
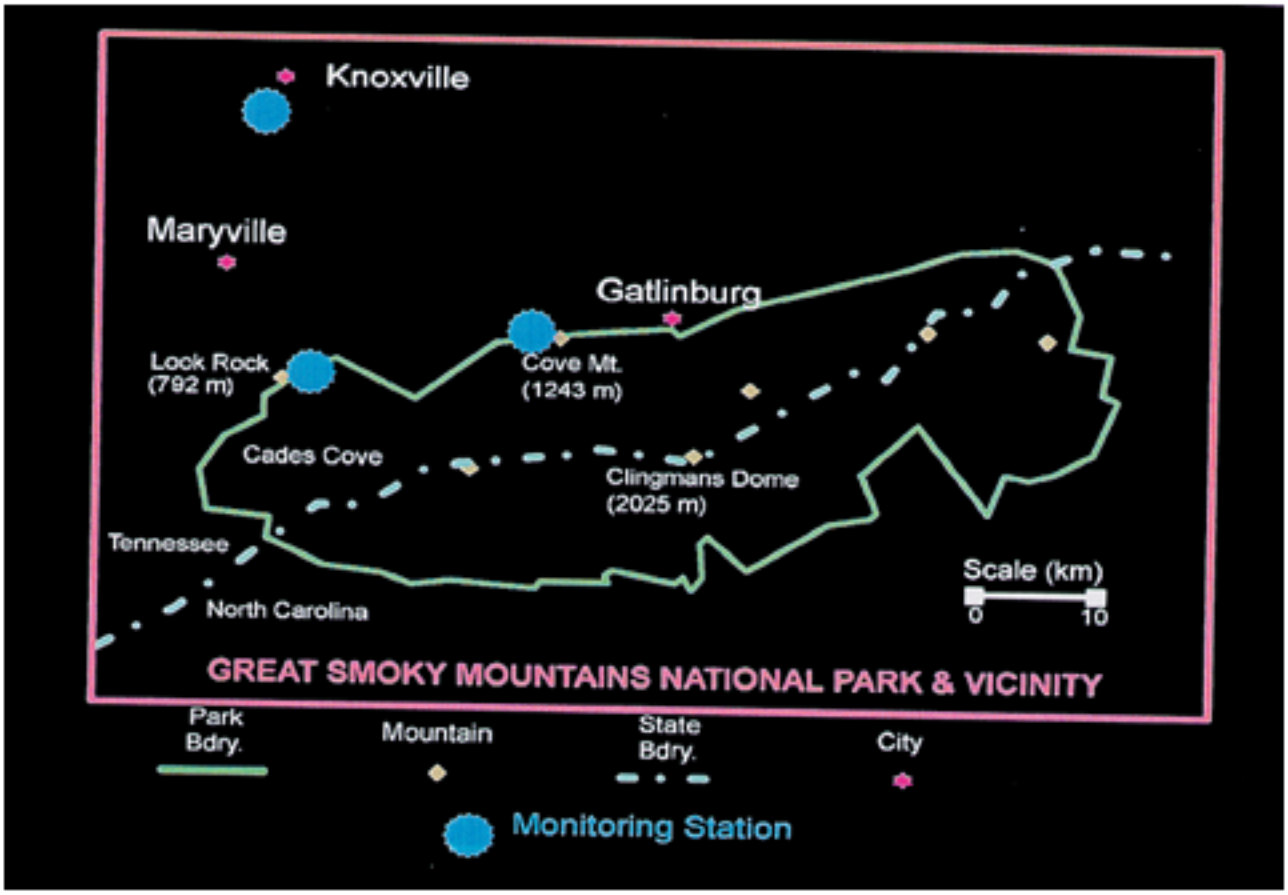


View of Look Rock Supersite Facing North



Map of Look Rock and Two Satelite Sites

If you would like additional information on important air quality topics, please consider any of the following "*On The Air*" issues. Please contact Jeanie Ashe by telephone (256-386-2033), E-mail (jbashe@tva.gov), facsimile (256-386-2499), or TVA mail (CEB 2A-M) if you would like to request one or more issues.

The Proposed Revision of the Ozone Standard Has Important Implications for the Tennessee Valley and the Nation. April 1997.

Much of the Tennessee Valley May Be Unable to Meet Particulate Matter Standards If Proposed EPA Revisions Are Adopted. April 1997.

Nitrogen Saturation Related to Acidic Deposition May Impact the Health of High-Elevation Forest and Aquatic Ecosystems. April 1997.

Improved Weather Predictions for TVA Operations Mean Cost Savings and Greater Efficiency. April 1997.

TVA's Contribution to Sulfate Deposition in the Southern Appalachians Will Be Further Reduced by Compliance With Title IV Regulations. July 1997.

Reductions in Sulfur Dioxide and Nitrogen Oxides Emissions Have Exceeded the Goals of the Acid Rain Control Program. October 1997.

Not All Nitrogen Oxides Emissions Are Created Equal in Terms of Their Ability to Produce Ozone. April 1998.

For Most Summer Days, the Impact of Soil Nitrogen Oxides Emissions on Ozone Production Is Minor, But on Hot Summer Days, It Can Be Significant. April 1998.

How Will Nitrogen Oxides Emissions Controls at Allen Fossil Plant Impact Ozone Levels in the Memphis Area? September 1999.

TVA Risk Assessment Results Demonstrate That TVA's Toxic Release Inventory Emissions Do Not Endanger Health. September 1999.